2 - FOREST HISTORY

2.1 - Pre-European Settlement History (Glaciation to 1800's)

The present physical geography of the State of Michigan is a direct result of the Wisconsinan glaciation of the Pleistocene Epoch, when the state was totally covered by ice. As the present inter-glacial period began and the ice sheet gradually receded, southern Lower Michigan became mostly ice free approximately 13,000 years before present (B.P.). Upper Michigan became ice free approximately 10,000 B.P. The present landform and soils of Michigan are the result of post-glacial lakes, rivers, erosion and soil development processes acting upon the glacial deposits, resulting in a diversity of terrain features including moraines, drumlins, eskers, kames, outwash plains and former lake beds that are interspersed with numerous lakes, streams and depressions, including four of the world's largest freshwater lakes.

It was upon this landscape of raw post-glacial parent material that life gradually returned. The primary succession of plant life was heavily influenced by the nature of the parent material, the climate (that was still very much influenced by the receding ice sheets) and the formation and disappearance of proglacial lakes. Theories of the succession of plant life from barren soil to tundra, and the migration of forest tree species and some animal species from their glacial refugia are fairly well established (Davis 1981 and Pielou 1991). Post-glacial succession and development of forest and animal communities were first driven by a gradual warming of the climate, culminating in the hypsithermal of the current interglacial occurring approximately 7,000 B.P., and then by the subsequent and present cooling trend toward the next glaciation. The post-glacial landscape provided an abundance of habitat for a wide diversity of forest, savanna and aquatic plant and animal communities, which were distinctly influenced by Native American cultures that inhabited the two peninsulas, most notably through hunting and fishing activities and their interaction with the fire regimes of both savanna grasslands and pine lands. A comprehensive description of the complexity of the post-glacial climatic and anthropogenic interaction with plant and animal communities can be found in Pielou 1991.

The present landscape of Michigan is comprised of four distinct eco-regions (Figure 2.1): Southern Lower Michigan; Northern Lower Michigan; Eastern Upper Michigan; and Western Upper Michigan. Each eco-region is distinct in its climate, physiography, soils and vegetation. These distinctions are a result of the peninsular configuration of the state, which dramatically affects the climatic differences of both peninsulas. The distinctiveness of warm, vegetatively diverse Southern Lower Michigan and cold Upper Michigan is largely due to their latitudinal positions and the continental land masses on their southern borders. The four Great Lakes that surround the state also provide a significant influence upon the climate in portions of both peninsulas (Albert 1995).

The pre-European settlement (circa 1800) vegetative patterns for the State are based upon an interpretation of the Federal General Land Office (GLO) surveys of 1816-1856 (Figure 2.2). Between 1816 and 1856 the State was surveyed by the Federal Government's General Land Office (GLO), with surveys of the Lower Peninsula beginning in 1816 and surveys of the Upper Peninsula beginning in 1840. The interpretation of cover types on these maps is interpolated from section line and corner witness trees, similar landform, surface geology and soils data. Inclusions of dissimilar cover types that do not intersect a section line may not be reflected upon the maps. Despite these qualifications, the GLO survey maps provide a consistent landscape level perspective of the circa 1800 cover types

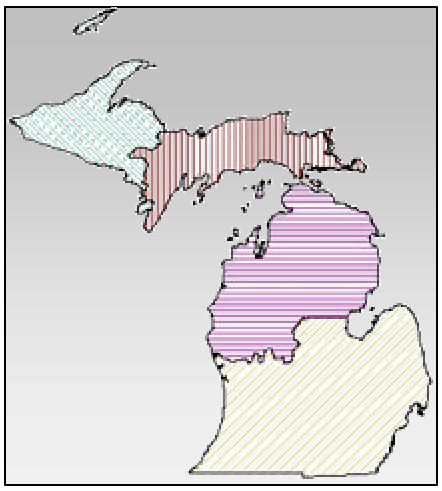

Figure 2.1. Regional Landscapes Ecosystems of Michigan.
(Adapted from Albert, 1995)

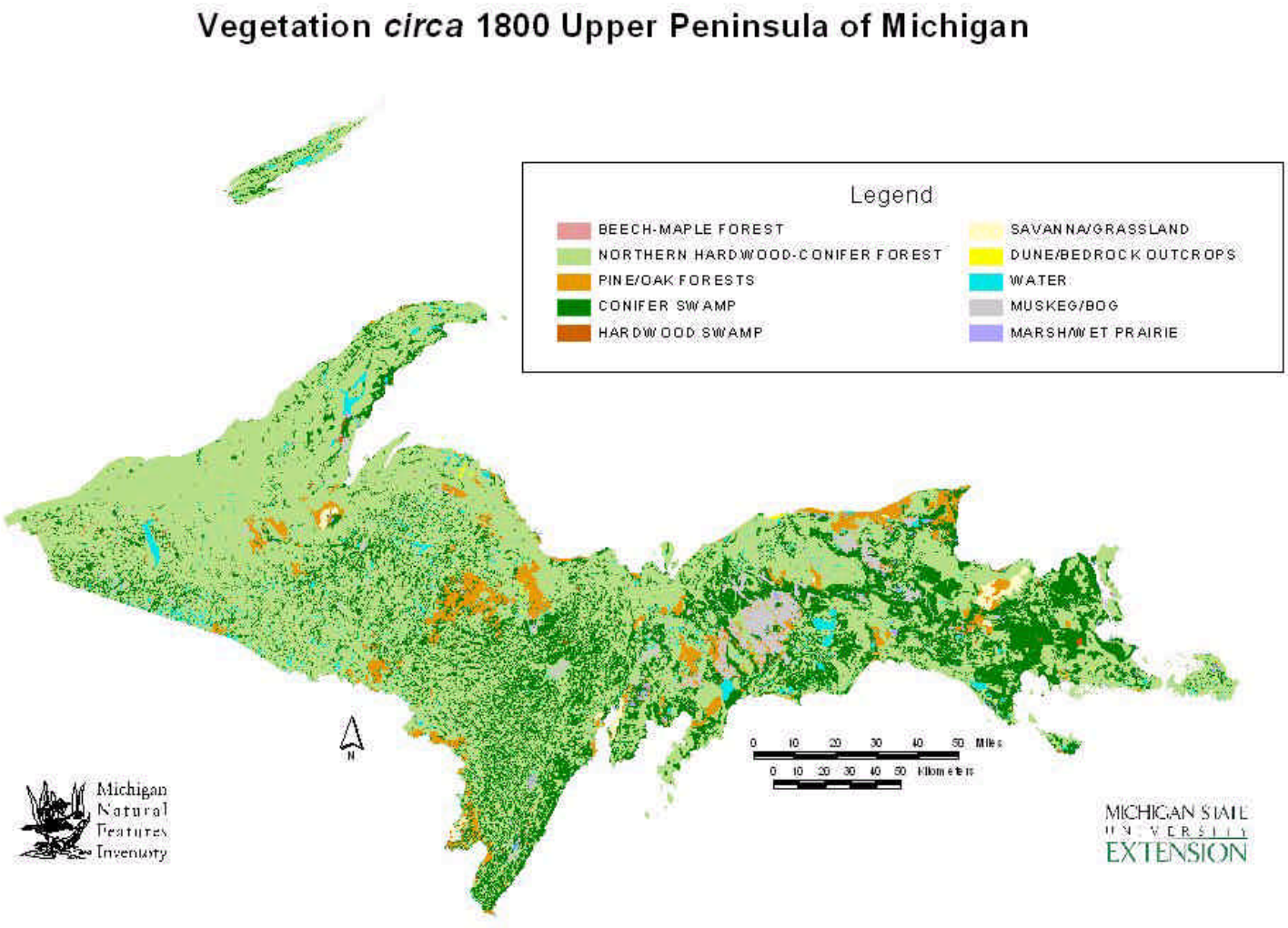

Figure 2.2. Vegetation of Michigan circa 1800.
(Michigan Natural Features Inventory, 1998)

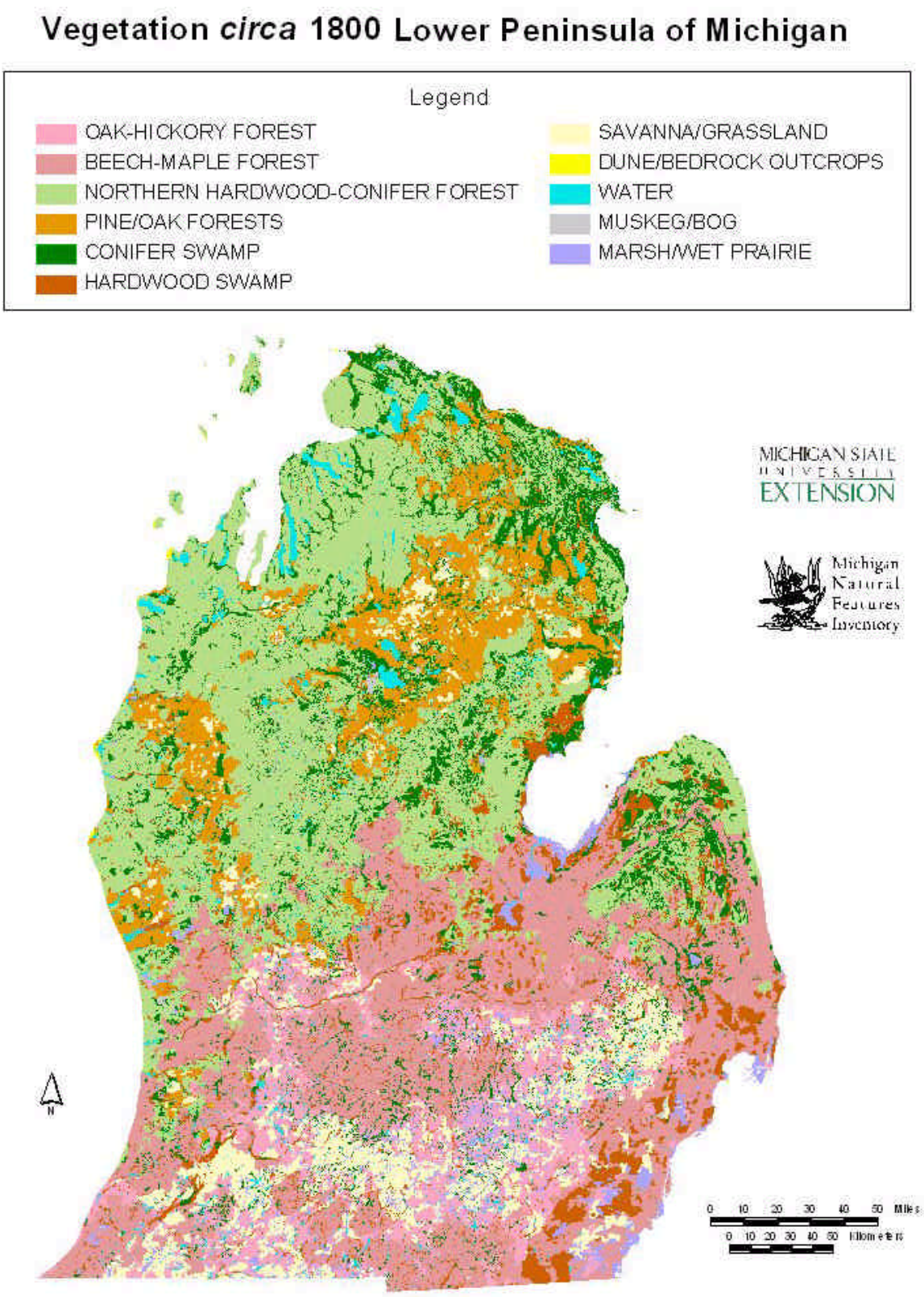

Figure 2.2 (Continued). Vegetation of Michigan circa 1800.
(Michigan Natural Features Inventory, 1998)

of the entire state. The maps are useful for assessing broad post-settlement trends for different cover types, the type and scale of pre-settlement disturbance regimes, and for consideration in the restoration of selected cover types.

The forest and other landscape communities that existed circa 1800 consisted of a mosaic of vegetative patterns ranging from remnant hypsithermal savanna grasslands and southern hardwood forests in Southern Lower Michigan, to northern hardwood and pine forests in Northern Lower Michigan and all of Upper Michigan (Figure 2.3 and Table 2.1). The pre-settlement landscape was dynamic and was comprised of a mosaic of community types in various stages of ecological succession, driven by long-term shifts in climatic conditions, and short-term natural and anthropogenic disturbance cycles. Four community types dominated the landscape at the time of the GLO surveys: the beech-sugar maple-hemlock northern hardwoods community; the beech-sugar maple southern hardwoods community; hemlock dominated communities; and the mixed conifer swamp community. Eight other sub-dominant communities occurred on the landscape: mixed oak savanna; oak/pine barrens; beech-sugar maple northern hardwoods - absent the hemlock component; mixed oak/hickory forest; mixed hardwood swamps; red/white pine forests; white pine/mixed hardwoods; and cedar swamps. Lesser communities were spruce/fir/cedar forests, seral aspen/birch forests, and black ash swamps.

As an aggregate group, pine communities covered 4.1 million acres or 11.8% of the forested landscape. These included pure white pine forests, pure red pine forests, pure jack pine forests, mixed red/jack pine forests , mixed pine/oak forests, and the previously cited red/white pine forests and white pine/mixed hardwood forests. The pine forest communities were fire-driven ecosystems, dependent upon occasional catastrophic stand-replacing fires for regeneration, and frequent low-intensity fires that eliminated competition from non-fire adapted tree species and that in the case of red and white pine maintained a relatively open structure on the forest floor. Conservative estimates of recurrence intervals for fires in jack pine forests in northern Michigan ranged from 59 to 140 years. For red and white pine stands, estimates of recurrence intervals in northern Michigan ranged from 130 - 240 years (Whitney 1986, Price 1994, Cleland et al. 2004).

The natural disturbance regime that maintained white pine communities was characterized by a repeating, cyclical sequence of catastrophic fires, with light surface fires occurring at shorter intervals (Frelich 1992). White pine occurred most abundantly in areas where catastrophic fire intervals were about 150 to 300 years. More frequent fires, towards the 100-150 year interval, tended to favor red pine while intervals greater than 300 years tended to succeed to northern hardwoods. As a mid-successional species, white pine occurred most frequently with red pine (Table 2.1) and most often followed jack pine (Frelich 1992). Non-catastrophic surface fires occurred at intervals of 20-40 years (Frissel 1973 as cited in Frelich 1992) and tended to kill hardwoods invading the understory. Gaps created by winds and surface fires created multi-modal diameter distributions and formed increasingly multi-aged stands. White pine stands may have been maintained in the old-multi-aged stage for one to several centuries (Heinselman 1981), until the occurrence of another catastrophic disturbance.

A view of the complexity of the landscape and the composition and structure of circa 1800 forests can also be gained through analysis of GLO data for the frequency of association of several major tree species within upland glacial landforms in Northern Lower Michigan (Table 2.2). Strong associations are evident between beech, sugar maple and hemlock

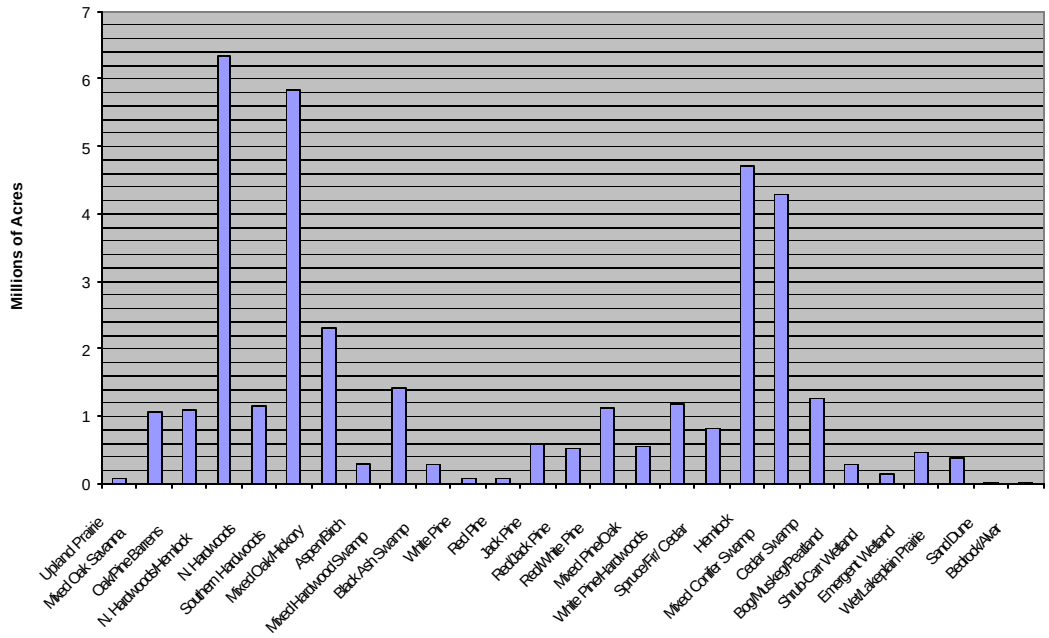

Figure 2.3. Circa 1800 Landscape Cover Types.
(Michigan Natural Features Inventory, 1998)

Table 2.1. Circa 1800 Cover types by acreage and percent relative cover.
(Michigan Natural Features Inventory, 1998)

Cover Type	Acreage	Percent
N. Hardwoods/Hemlock	6,341,989	18.1
S. Hardwoods	5,845,677	16.7
Hemlock	4,714,602	13.5
Mixed Conifer Swamp	4,290,553	12.3
Mixed Oak/Hickory	2,306,373	6.6
Mixed Hardwood Swamp	1,421,462	4.1
Cedar Swamp	1,254,055	3.6
White Pine/Hardwoods	1,185,681	3.4
N. Hardwoods	1,161,644	3.3
Red/White Pine	1,132,097	3.2
Oak/Pine Barrens	1,101,424	3.1
Mixed Oak Savanna	1,061,564	3.0
Spruce/Fir/Cedar	823,253	2.4
Jack Pine	596,836	1.7
Mixed Pine/Oak	543,562	1.6
Red/Jack Pine	515,819	1.5
Aspen/Birch	292,266	0.8
Black Ash Swamp	280,705	0.8
Red Pine	70,889	0.2
White Pine	69,141	0.2
Totals	35,009,591	100

Table 2.2. Frequency of Association of Tree Species with Upland Landforms in the Northern Lower Peninsula prior to European Settlement.
(Fisher, 1994)

	Upland Landform							
Species	Outwash Plains	Ice Contact Features	End Moraines of Fine-Textured Till	End Moraines of Medium-Textured Till	End Moraines of Coarse-Textured Fill	Ground Moraines of Fine-Textured Till	Ground Moraines of Coarse-Textured Till	Lacustrine Sands and Gravels
Sugar Maple	7.7	11.8	6.5	24.8	21.4	8.7	16.4	10.1
Hemlock	6.9	11.7	20.8	17.7	17.1	27.1	17.9	23.4
Beech	11.0	17.8	11.7	37.1	31.7	16.7	22.6	18.8
White Pine	17.1	14.0	16.7	4.9	8.9	24.3	11.9	22.0
Red Maple	2.3	2.0	1.8	0.7	3.0	8.3	1.3	4.9
White Oak	6.5	1.7	0.7	1.2	1.6	0.3	0.2	1.3
Red Oaks	1.9	2.4	2.3	0.5	1.3	0.4	1.7	0.1
Red Pine	15.5	20.5	21.4	5.2	5.3	3.7	14.9	5.5
Jack Pine	20.8	11.7	8.1	0.8	1.5	0.0	3.2	1.4
Aspens	1.4	3.0	3.6	0.7	0.8	1.3	2.3	1.8
Other Hardwoods[a]	8.2	3.4	4.8	6.0	7.2	7.2	6.1	6.7
Other Conifers[b]	0.7	0.0	1.6	0.4	0.2	2.0	1.5	4.0

[a] Includes ash, elm, basswood, paper birch, yellow birch, and black cherry.

[b] Includes balsam fir and white cedar.

upon medium and coarse- textured end moraines, and coarse- textured ground moraine features. On fine-textured ground moraines and lacustrine deposits hemlock, white pine and beech were dominant components of the forest community. Fine-textured end moraines were dominated by hemlock and red and white pine. Outwash plains were dominated by communities of jack, white and red pine. The species diversity and the complexity of the circa 1800 forest landscape are evident in by the variety of component species in each of the different landforms, which is a reflection of natural patterns of disturbance and species succession.

The diversity of circa 1800 forests is also reflected through analysis of a Northern Hardwoods Community in Chippewa County, Michigan (Table 2.3). Some elements of community structure are apparent by the density of 141 trees per acre (with sugar maple, hemlock, yellow birch and beech dominating in number) and the basal area of 154 square-feet per acre (with hemlock, sugar maple, yellow birch and white pine dominating the canopy of the forest).

The complex community composition in the circa 1800 northern hemlock-hardwood forest community was driven by a combination of long-term climatic-driven trends and the different adaptations to disturbance exhibited by different tree species. A contemporary study of the Sylvania Wilderness Area in Western Upper Peninsula is informative for gaining an understanding of the historical development of this forest community (Davis, et al. 1994). The study included an analysis of a palaeoecological record of pollen assemblages, which showed a dominance of a very fire prone red and jack pine community approximately 7,000 years B.P., correlating to the hypsithermal of the current interglacial. During the subsequent cooling trend a somewhat less fire-prone community of white pine, oak and red maple succeeded upon the site and dominated from 7,000 to 3,000 years B.P., with an average fire recurrence interval of 150-340 years (Frelich 1992).

Table 2.3. Species density and dominance in the circa 1800 Northern Hardwoods Community of Chippewa County, Michigan.

(Price, 1994)

Species	Number of Trees	Relative Density	Trees/Acre	Total Basal Area[1]	Relative Dominance	BA[1]/Acre
Aspen	6	0.7	1.0	2.0	0.2	0.3
Beech	86	10.4	14.6	53.6	5.9	9.1
Balsam Fir	55	6.6	9.4	21.2	2.3	3.6
Black/Red Oak	2	0.2	0.3	5.9	0.7	1.0
Basswood	4	0.5	0.7	5.4	0.6	0.9
Hemlock	170	20.5	29.0	252.3	27.8	42.9
Ironwood	3	0.4	0.5	0.7	0.1	0.1
Red Maple	68	8.2	11.6	35.5	3.9	6.0
Red Pine	2	0.2	0.3	3.5	0.4	0.6
Sugar Maple	235	28.4	40.0	206.1	22.8	35.0
Spruce	30	3.6	5.1	21.3	2.4	3.6
White Birch	9	1.1	1.5	7.1	0.8	1.2
White Pine	42	5.1	7.2	136.7	15.1	23.2
Yellow Birch	116	14.0	19.8	154.7	17.1	26.3
Totals	828	100	141	906	100	154

[1] Basal Area measured in square-feet.

Rapid increases in the abundance of hemlock and yellow birch became evident in the pollen record starting 3,200 years B.P. as the frequency of fires continued to decrease, with fire recurrence intervals extending to approximately 1,400-2,200 years (Whitney 1896, Price 1994). Sugar maple and basswood entered the forest soon after the invasion of hemlock and yellow birch, and windthrow gradually became the predominant form of disturbance, with recurrence intervals of approximately 1,200-2,200 years (Whitney 1986, Frelich and Lorimer 1991, Price 1994). Where the intervals between fires were long, the white pine-oak-red maple forest was succeeded by hemlock and yellow birch at some locations and by sugar maple, yellow birch and basswood at other locations (dependent upon different edaphic site conditions), giving rise to the mosaic of hemlock, sugar maple, yellow birch and white pine dominated the circa 1800 northern hardwood forests.

Before settlement, grasslands such as wet meadows, oak and pine barrens, dry sand prairies, and tall grass prairies were scattered throughout Michigan, but the largest acreage was in the southern Lower Peninsula. At least 39 grassland areas were present, totaling approximately 2.3 million acres. Fire was an important element in the establishment and maintenance of these grasslands. Whether caused by lightning or set purposely by Native Americans, fire stimulated grass and wildflower growth, reduced competition, and discouraged the encroachment of shrubs and trees.

2.2 - Post-European Settlement History (1600's to 1900)

European settlement of the State began soon after the expeditions of the Great Lakes region in the 1600s by the French explorers Etienne Brule and Robert René Cavelier de La Salle, beginning with the establishment of Jesuit missions at Sault Ste. Marie in 1668 and at St. Ignace in 1671. The fur trade drove the early development of the State. Ease of access

for trading determined the location of other early French settlements in St. Joseph in 1679, present day Detroit in 1701 and at Fort Michilimackinac in 1715.

Michigan became established as a territory in 1805, and became the twenty-sixth state in the union in 1837. Following the GLO surveys in Southern Lower Michigan, land was cleared at a relatively slow, laborious pace for agriculture. However, it was the land surveys of the wilderness of Northern Michigan that led to the discovery of Michigan's extensive pine forests, and fueled the subsequent rush by timber speculators beginning in the 1850s.

Early (mid-1830s) government figures from the surveyor's findings estimated the volume of standing pine timber in Michigan to be 150 billion board-feet (at 2 cords per 1,000 bd-ft this is equivalent to approximately 300 million cords). The lumber boom started in the 1850s in the Saginaw River watershed, and quickly spread westward and northward. By 1897 it was estimated that more that 160 billion board-feet of pine had been cut, with only about six billion board-feet of standing timber remaining, mostly in the Upper Peninsula. In a mere 70 years most of the original pine and hardwood forests of Michigan were gone.

Following the logging of the forests, attempts were made to settle cut-over lands for farms. To prepare the land for agriculture vast amounts of residual slash had to be cleared from the landscape. The common practice to accomplish this was to burn it. This practice combined with the release of cinders from steam locomotives provided the sparks for a period of devastating wildfires, including the firestorm of October, 1871 which alone burned approximately 2.5 million acres. Fires occurred continuously over the following six decades, interspersed by additional large conflagrations in September of 1881 (over 1 million acres), October of 1908 (2.4 million acres) and in July of 1911 (156,480 acres). These fires consumed slash, homes and lives and also destroyed millions of trees and estimated 73 billion board-feet of timber that had previously been spared from logging. It is estimated that for every two trees that were cut for lumber, one additional tree was destroyed – mostly due to the wildfires (Dickman and Leefers 2003).

European settlement brought major degradation to inland lakes and streams and Great Lakes water resources. Land clearing for agriculture, logging, and settlement altered local stream flow patterns and volumes, eliminated some waters, and introduced pollutants into others. Huge quanitities of sediment from log drives and sawdust from sawmills were dumped into rivers. In one instance, the mouth of the Manistee River accumulated sawdust to the extent that it formed a delta of several square miles. At sawmill locations throughout the state, wherever sawdust was dispensed into the river, toxic and oxygen deprived conditions were created for fish. These detriments, combined with land clearing efforts that exacerbated soil erosion into rivers, significantly reduced the quality of fish habitat in rivers and drowned river mouths. Drainage of wetlands and shallow water tables for agriculture did likewise. Dam and road construction caused extensive fragmentation of formerly interconnected waters and contributed to the elimination or reduction of many highly-migratory fish populations. Dam construction also caused severe water quality changes and eliminated rare high-gradient river sections. Over-fishing of the most productive and larger water bodies eliminated or reduced fish populations.

Intensive commercial fisheries existed both in the Great Lakes and the large rivers tributary to the lakes and the numbers of commercial fishers increased through the mid 1800s (Garling et al. 1995). Interest in recreational fishing increased as people had more time to recreate and fishing equipment was developed. In 1859, 14 lower counties in Michigan prohibited fishing with nets (commercial fishing) in order to accommodate recreational

fishing. By the late 1800's, recreational fishing was well established in inland waters, while commercial fishing still dominated in the Great Lakes. At the same time that habitat was compromised, enormous exploitation was also occurring.

The creation of the Michigan Fish Commission in 1873, the ancestor of the Department of Natural Resources – Fisheries Division, can be directly linked to the demand for more fish in Great Lakes waters and more "desirable food fish" in inland waters. To address this desire, Michigan implemented fish stocking as a management tool, and continued the practice for the next 133 years. From 1873 to 1897, the Michigan Fish Commission stocked millions of lake whitefish and lesser numbers of many other species into Great Lakes waters to address the rapid declines in commercially important fish. Many of these Great Lakes species and also numerous non-native fish species were also stocked in many inland waters. During this time, common carp (*Carpio cyprinus*) and other popular species such as brown trout (*Salmo trutta*) and rainbow trout (*Oncorhynchus mykiss*) and steelhead (the migratory form of rainbow trout) were introduced into inland waters.

Human activity during the post-European settlement period also had profound impacts upon terrestrial wildlife populations of the state. Since wildlife are inextricably connected to the habitat that supports them, large scale changes in vegetative cover such as timber harvest, fire, agricultural land conversion and subsequent reversions back to forest cover have been the nexus for many trends in wildlife populations. Some species benefited by these changes while others experienced declines. Examples of species that benefited from the change from the pre-settlement landscape to open plains and early successional aspen forests are white-tailed deer, sharp-tailed grouse (*Tympanuchus phasianellus*), ruffed grouse (*Bonasa umbellus*), and American woodcock (*Scolopax minor*). The forested landscape of pre-settlement Michigan did not support large numbers of these species, but each experienced population booms in the early through mid-twentieth century due to the availability of additional habitat which was the result of the clear cutting of forests. White-tailed deer populations were been greatly influenced by harvest pressures. By 1876, market hunters were killing 70,000 deer each year to supply the booming lumber camps, and shipped what they couldn't sell locally to big cities such as Chicago and Detroit. At about the same time fires burned over large areas of early successional habitat, causing a loss of forage. Together, these two factors then caused a rapid decline in deer numbers.

The decline of other species can also be directly attributed to over-exploitation by hunting. As markets for wild meat developed, Michigan gained prominence as a source of wild meat for large eastern and mid-western markets. Market hunters removed large numbers of a wide variety of waterfowl, shorebirds and small game for meat, while other birds were taken for their plumage for stuffing or to adorn hats. Market hunting of the passenger pigeon (*Ectopistes migratorius*) alone killed approximately 1.5 million birds near Petoskey in the summer of 1878. As the United States population grew, the demand for wildlife as a food source also increased. This demand led to the overexploitation of many Michigan species and resulted in severe population declines for some species and the extirpation of other species.

Wildlife species extirpated during and following this period include the bison (*Bison bison*), elk (*Cervus elaphus*), woodland caribou (*Rangifer tarandus*), cougar (*Felis concolor couger*), wild turkey (*Meleagris gallopavo*), passenger pigeons, trumpeter swan (*Cygnus buccinator*), fisher (*Martes pennanti*), and American martin (*Martes americana*). Wildlife and invertebrate species nearly extirpated or greatly reduced in the state include beaver (*Castor canadensis*), gray wolf (*Canus lupus*), moose (*Alces alces*), black bear (*Ursa americanus*),

American martin (*Martes americana*), Canada goose (*Branta Canadensis*), lake sturgeon (*Acipenser fulvescens*), piping plover (*Charadrius melodus*), Kirtland's warbler (*Dendroica kirtlandii*), prairie warbler (*Dendroica discolor*), and Karner Blue (*Lycaeides melissa samuelis*), Frosted Elfin (*Incisalia irus*), Persius Duskywing *(Erynnis persius*), Dusted Skipper *(Atrytonopsis hianna*), Ottoe Skipper *(Hesperia ottoe*), Dukes' Skipper *(Euphyes dukesi)*, and Mitchell's Satyr (*Neonympha mitchellii mitchellii*) butterflies.

With the industrial age and the rise of modern agricultural methods the reliance on wildlife as meat and revenue sources declined. In many cases the wildlife population declines were so severe that they could no longer support commercial activities. As populations of wildlife declined or disappeared in the state from overexploitation, public attitudes began to change, and recovery began by increasing enforcement of laws and regulations protecting wildlife. The State began enacting a series of laws protecting various species of wildlife. The first salaried game warden in the country was appointed in 1887 and Michigan's first deer hunting license was created in 1895. In 1897, a bill was introduced in the Michigan legislature in a futile attempt to establish a ten-year closed season on passenger pigeons. Toward the end of the nineteenth century the importance of wildlife as a commercial resource began to decline and the importance of wildlife as an economic commodity began to evolve. The value of an animal was no longer simply measured by the price it would attract in a market. The value became recreational, measured by the amount of money expended for the licenses, equipment and other amenities necessary for its pursuit. Sport hunting thus largely replaced commercial activity.

2.3 - Contemporary History (1900 to the present)

Many settlers found that the climate and the sandy, burned over soils of Northern Michigan were often marginally productive for farming and many areas were simply abandoned. The State of Michigan thereby inherited a large portion of the cut-over pine lands of Northern Michigan due to the non-payment of taxes during the early twentieth century. By 1907, almost half of homesteaded land had reverted to the state. Many of these lands tax reverted several times after being repeatedly sold by the state, and the question of what to do with these lands was a serious public policy issue.

One answer came through the rise of a new industry in northern Michigan in the early 1900s: that of recreation and tourism which provided a new use for the miles of Great Lakes shoreline, inland lakes and streams and other remaining natural resources. This trend was closely related to the growth of the automobile, the state highway system and a middle economic class in a large segment of the population, whose increasing wealth and free time resulted in greater demand for recreational opportunities. During this period it was recognized that re-growth of forests and the recovery of natural ecosystems was the foundation for the well-being of the recreation and tourism industry.

A Forestry Commission was established by the Forest Commission Act of 1899, which also authorized the withdrawal of abandoned cut-over lands for forest reserves. The Forest Reserve Act of 1903 authorized the Forestry Commission to establish a State Forest Reserve on about 34,000 acres in western Crawford and Roscommon Counties, which was the beginning of the present state forest system. The Forestry Commission was abolished in 1909 with the creation of the Public Domain Commission, which was charged with receiving tax-reverted lands and administration of the increasing public domain.

Concurrently, the Forest Reserve Act of 1891 gave the president the authority to establish national forests. The present Huron and Hiawatha Forests were subsequently established in 1909, the Ottawa National Forest in 1931 and the Manistee National Forest in 1938.

To stabilize the forest landscape it was recognized that protection from wildfire was required. The state legislature enacted the Forest Fire Act of 1903, which first authorized the designation of a Chief Fire Warden. The Chief Fire Warden was placed in general charge of a fire warden force that was in turn charged with preventing and controlling forest fires. Fire towers were constructed between 1912 and 1942 to provide a network for early detection of forest fires. When the State Department of Conservation (the precursor to the present Department of Natural Resources) was created in 1921, fire control was a primary responsibility upon the state forest reserves. The Forest Fire Law of 1923 authorized fire control outside of state lands.

Since 1935, the general stability in the area of forestland in Michigan can be attributed to forest fire control and activities dedicated to forest management, including forest regenereation. The Civilian Conservation Corps (CCC) was established in the early 1930s to help in this effort to revitalize tax-reverted cut-over public lands. Between 1933 and the start of World War II the CCC fought forest fires and planted approximately 485 million trees in Michigan, including extensive pine restoration plantings on 134,000 acres (Dickman and Leefers 2003).

Concurrently with the efforts of the CCC, work continued for the restoration of game species. In 1937, Congress passed the Federal Aid in Wildlife Restoration Act (Pittman-Robertson) to support state efforts in wildlife restoration. This program along with state hunting and fishing license revenues continues to support wildlife restoration activities in Michigan. Natural biotic succession was also occurring. In the early 1900s, the re-growth of burned over lands and restrictions for hunting allowed white-tailed deer numbers to rebound to approximately 1.5 million by 1949. However, as the regenerating forests matured and openings closed in, there was a decline in forage and an associated decline in deer numbers starting in the 1950s. An increase in the timber market in the 1970s along with a deer range improvement program reversed the downward trend and led to the highest deer numbers (approaching 2 million) in the history of Michigan in 1989. Disease concerns became a major issue with the discovery that bovine tuberculosis was endemic in a wild white-tailed deer population of northern Lower Michigan in 1994.

Other species of wildlife began returning to the state, either on their own or through dedicated restoration programs. Around 1907, moose migrated (probably over on winter ice from Ontario) to Isle Royale. In 1934-37, the (then) Michigan Department of Conservation undertook a project to reduce moose numbers on Isle Royale and replenish the mainland UP moose herd with animals from Isle Royale. Seventy-one moose were captured and relocated to mainland Michigan. In 1985 and 1987 an additional 59 additional moose were relocated from Ontario to Marquette and Baraga Counties. In 1918, seven elk were relocated from western states and released near Wolverine. The year 1918 also saw the enactment of the Migratory Bird Treaty Act, which stopped hunting of migratory bird species such as the piping plover. Turkeys were re-introduced into Michigan during the 1950s. Restoration of marten populations began around 1958, with the relocation of animals from Ontario into the Porcupine Mountains in the western Upper Peninsula. Additional releases were conducted in Upper Michigan in the 1970s and in northern Lower Michigan in 1985 to supplement existing populations. Fishers were first reintroduced in the 1960's on the Ottawa National Forest in western Upper Michigan. During the 1980s, Michigan began a

trumpeter swan reintroduction program as part of the North American Restoration Plan. Successes in the re-introduction of wildlife species was countered by the decline of other species. For example, by 1912, common loons (*Gavia immer*),were no longer as common in the more heavily settled areas of southern Michigan.

From 1897 through 1964, the Michigan Fish Commission (later called the Michigan Conservation Department) did not actively manage Great Lakes waters other than to regulate commercial harvest, though regulation was without a clear understanding of limits on fish productivity and the potential impacts of over-harvest. Essentially, commercial harvest was allowed to continue unencumbered by the regulations in place.

Large changes in the fishery community for both the great lakes and inland waters were underway. Arctic grayling were extinct by early the 1900's in spite of efforts to produce the species in hatcheries. Several other species were deemed extinct due, at least partially, to overexploitation: blue pike (*Sander vitreus glaucus*), longjaw cisco (*Coregonus alpenae*), blackfin cisco (*Coregonus nigripinnis*), and deepwater cisco (*Coregonus johannae*) (Eagle et al. 2005). Sea lamprey (*Petromyzon marinus*) invaded the Great Lakes in the early 1900's through the Erie Canal, with reproducing populations in high abundance by the mid-1900's. With both an inland and great lake component to their life cycle, this parasitic lamprey was particularly devastating to lake trout populations. A sea lamprey control program was developed through the Great Lakes Fishery Commission in 1958 that continues today.

Another invasive species, alewife (*Alosa pseudoharengus*), became prominent in the Great Lakes in the 1950s. At this time, lake trout numbers were very low as a result of commercial exploitation and sea lamprey parasitism. Without an effective predator such as lake trout, alewife numbers swelled and dieoffs occurred in large magnitude along the shorelines of the lakes.

At the same time, a growing interest in recreational fishing opportunities on the Great Lakes became apparent to fisheries managers. The Department of Conservation followed by the Department of Natural Resources made a decision to introduce hatchery raised Pacific salmonids to control nuisance alewife populations and produce a sportfishery. A similar management philosophy led to stocking lake trout in Lake Superior to restore predator populations. The migratory salmonids have since adapted to reproduction in freshwater and use inland rivers to spawn and provide growing habitat for juveniles.

Environmental and fishery management practices since the mid 1900s assisted in rehabilitating many aquatic ecosystems. In particular, reforestation programs have stabilized forested landscapes, hydrologic and sediment processes, and waters therein. The federal Clean Water Act of 1972 removed the most serious water quality impairments and fishery management practices have rehabilitated many valued species of aquatic and terrestrial animal species. The ban of DDT and other similar persistent pesticides in the 1970s has contributed to a reduction in contaminant loading in fish and a significant rebound of some bird populations, such as bald eagles (*Haliaeetus leucocephalus*), osprey (*Pandion haliaetus),* peregrine falcons (*Falco peregrinus*), which were hard hit by the liberal use of pesticides shortly after World War II.

The importation of non-native insects and disease has had a counterbalancing effect upon the re-growth of Michigan's forests, with exotics such as the chestnut blight, Dutch elm disease, gypsy moth in the 1900s and most recently the emerald ash borer causing declines in a number of native tree species.

By 1939, more than two million acres of land had entered the public domain, and by the early-1940s almost 5 million acres were under the management of the Department of Conservation. As of 2003, approximately 19.3 million acres of Michigan's total land area of 37,258,240 acres is again forest land (Figure 2.4). This represents 53% of the total land area, and an increase of 5.5% since 1980. This forest land is located predominately in the northern two thirds of the state. Michigan's 18.7 million acres of timberland is the fifth largest in the United States, exceeded only by the states of Georgia, Oregon, Alabama, and North Carolina. Timberland acreage has increased 7% since 1980 (U.S. Forest Service data).

Present vegetative communities and their dependent animal populations have been in an almost constant state of instability and adaptation over the past 20,000 years. This is due, in part, to a changing climate, fundamental changes in the configuration of the land and the composition of its surficial materials (Davis 1986), and the impact of more recent human activity.

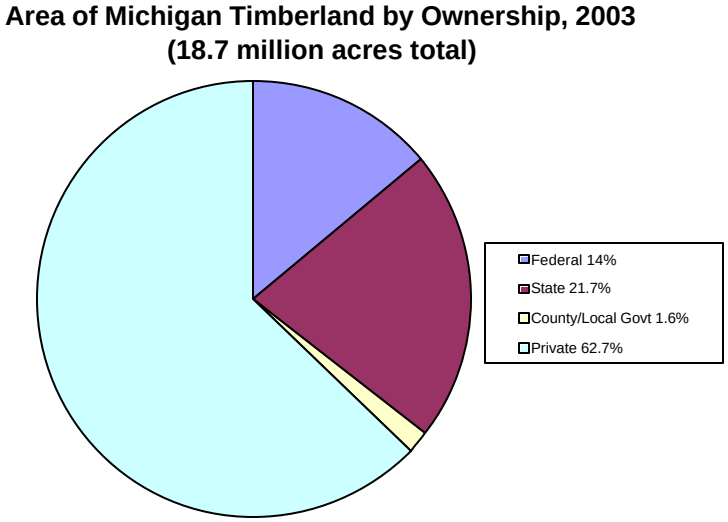

Figure 2.4. Area of Michigan Timberland by Ownership.
(U.S. Forest Service, 2003)

Over the past century, widespread extraction of the State's natural resources -- including timber, minerals, fish and game – was done on a momentous scale. There are many legacies from this period, which include the deforestation, burning and reforestation of large portions of the State, the severe degradation and slow recovery of aquatic habitats from erosion and disruption of natural hydrologic cycles, the loss of many aquatic and terrestrial wildlife species due to loss of habitat and over-exploitation, and rapid population growth of other wildlife species that were well adapted to the early successional communities present upon the landscape in the early to mid-20th century. Another legacy was the formulation of progressive policies and management to restore, enhance, and use natural resources in a sustainable fashion.

The past century's resource-based activity has led to several economic and social conditions, many of which carry through to the present day in the northern regions of the State. For example, in many areas of the northern lower peninsula, there is a transition

going on from a predominately timber-based economy to a more diversified timber, recreation and agricultural-based socio-economic system. In the upper peninsula, changes have been more gradual, but a trend from a timber and mineral-based economy to a timber and recreation-based socio-economic system can be perceived.

The State will never again see vast forest acreages similar to those present in the circa 1800 period. Yet inventory data indicate that the forests of the state have been on a steady path towards recovery from the over-exploitation and fire devastation that took place at the end of the 19th Century and the beginning of the 20th Century. This indicates that timber and other natural resource-based industries will remain significant, contributing segments of the social and economic fabric of the state for the foreseeable future.

3 - CURRENT FOREST CONDITIONS, USES AND TRENDS

The present forests of the State are a legacy of the natural vegetative succession pathways and post-settlement practices. The landscape is mostly composed of second growth forests that have been heavily influenced by a variety of human-induced disturbances. This started with harvesting of white and red pine and many other species, followed by large-scale catastrophic wildfires fueled by the resulting slash, and then moving to a period of near total exclusion of fire from the landscape. Few of these secondary forests possess the structural characteristics of the circa 1800 forests. With the exception of some rare community types, the state's present population levels, ownership patterns, and social and cultural values preclude the restoration of our remaining forests to circa 1800 conditions. Such restoration would necessitate dramatic changes in timber production, wildlife management and many forms of recreation.

The re-growth of the forest resource has presented us with more choices for management of these resources, including timber production, many forms of recreation, the provision of terrestrial and aquatic wildlife habitat, and the provision of other ecosystem services (such as maintenance of water and air quality, soil conservation, and carbon sequestration). However, this has also made management of these resources much more contentious, as different interests compete to use the State's forest resources for increasingly conflicting purposes. The capacity of forest resources to provide for these uses in a sustainable manner is finite. Since uses are not perfectly compatible, the forest cannot provide maximum use for all demands. Provision of one use is often constrained by demands for other competing uses for the same resource, and the capacity of the forest base to provide for these competing uses is infinite in its variability. Thus, the annual capacity of forest resources must be framed in terms of balancing competing uses. Emphasis should be on the means to enable uses to be compatible with other uses, with the recognition that at any one site one value or use may predominate over others.

In order to effectively formulate appropriate management strategies in this environment, it is helpful to have an understanding of the changes in forest composition and structure that has occurred over the past 150 years and the ecological consequences of those changes. According to Noss (1999), it is difficult to develop a strategy to manage forests in a sustainable manner without identifying the specific structural and functional changes that have led to current conditions. An understanding of how historical events have led to current forest conditions, coupled with an analysis of current inventory data and current uses of the forest resource base can provide the foundation for present strategies and future structural changes that will support sustainable forest management.

This section describes the current condition of DNR forest resources and the current capacity of its uses. It will also explore the ecological consequences of these uses in terms of changes in